City of Forest Grove

Street Tree Inventory Report

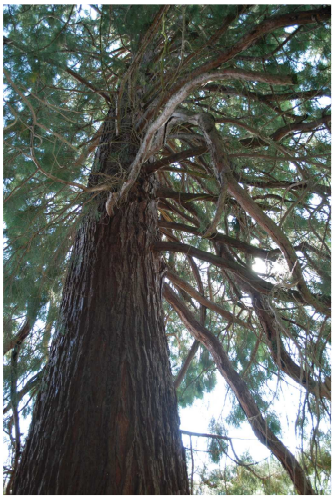
May 2011











FOREST GROVE
Where Oregon pinot was born

TREE CITY USA.

Street Tree Inventory Report: City of Forest Grove

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FOREST GROVE
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1 | Introduction

This report provides the results of a sample street tree inventory conducted in the City of Forest Grove in 2011. 2,050 street trees from 14 different neighborhoods were inventoried from January to early April 2011 by City of Forest Grove Interns. The data collected included location, tree type, condition, and size (diameter at breast height). A certified arborist was consulted with specific questions and accompanied the interns on several spot checks as a form of quality control. Interns completed data entry and analysis in order to:

1. Determine the current structure, composition, condition, and replacement value for the city's street tree resource;
2. Quantify the environmental services and aesthetic benefits provided by street trees, and;
3. Produce recommendations to guide investment in and management of the City of Forest Grove's street tree resource.

The study design, field data collection, and data analysis methods used to produce this report are part of the iTree Tools developed by the U.S. Forest Service. It includes guidelines to design the street tree inventory, programs to assist in paper-based or electronic field data collection, and software which analyzes the field data and produces outputs which detail the structure, function, and benefits of the urban forest.

A sample of key findings detailed in this report is presented in brief below.

- The street tree population is estimated at 27,419 trees of 158 different types.
- The top three most abundant trees are japanese maple (*Acer palmatum*), japanese flowering cherry (*Prunus serrulata*), and norway maple (*Acer platenoides*).
- The top ten most abundant tree species comprise nearly half (46.3%) of the urban forest.
- Broadleaf deciduous trees are the dominant tree type, composing 69.3% of all street trees.
- Greater than half (58.9%) of the street trees are 12" DBH or less.
- Approximately 350 acres, corresponding to 10% of the total land area in Forest Grove, are covered by the street tree canopy.
- The total replacement value for Forest Grove's street trees is estimated at $148,273,010.
- Street trees remove nearly 8 million pounds of air pollutants per year, a service worth more than $72 thousand.
- Forest Grove residents save close to $69,000 per year in avoided energy costs from the shading and wind calming effects of street trees.
- Street trees provide more than $1.2 million in property resale value per year.

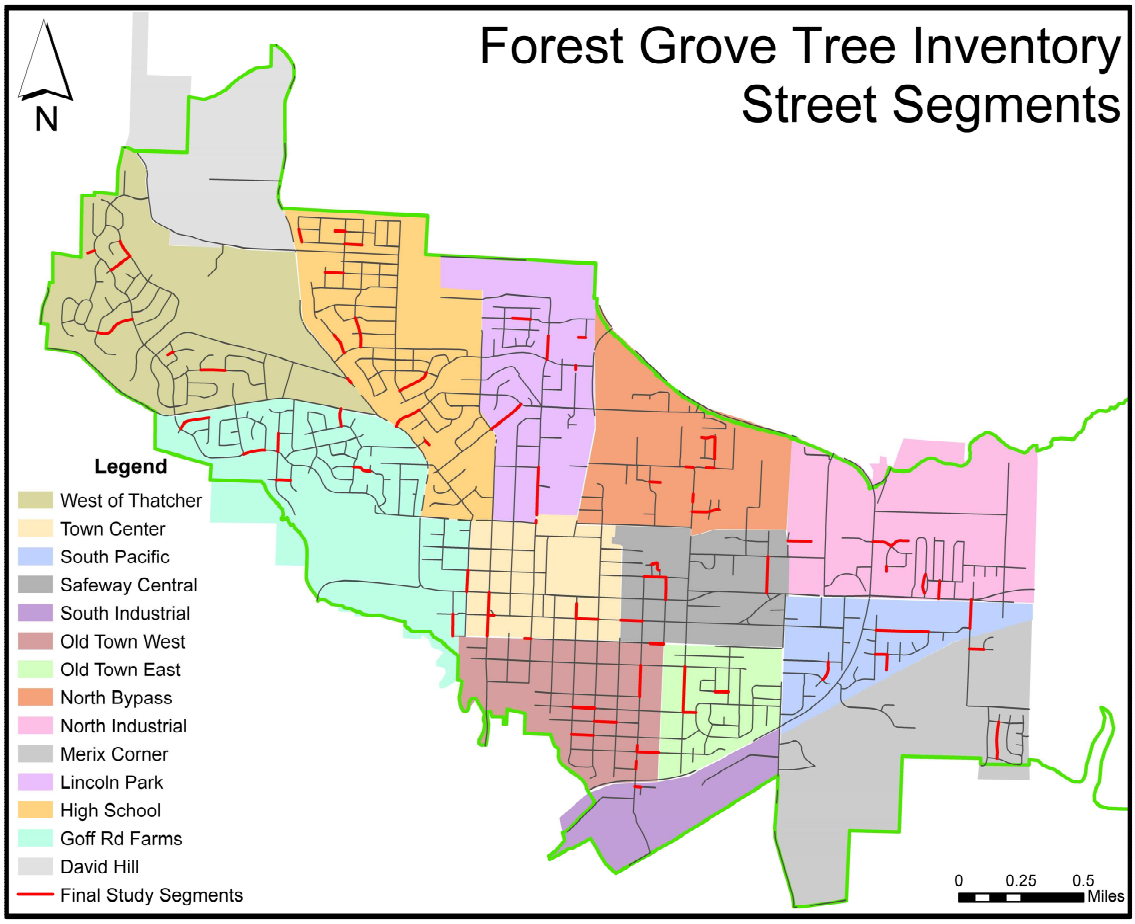
All data is available to the public for viewing at the City of Forest Grove Planning Division in spreadsheet, ArcGIS, and iTree Streets formats.

2| Methods

Establish Project Scope

The first step of the project consisted of determining the study area. Since a complete inventory was not feasible with the existing personnel and the project timeline, a sample inventory was conducted instead. In order to ensure the sample street tree inventory reflected the composition of the entire street tree population in Forest Grove, it was necessary to sample between 3-6% of all street segments within the city limits. According to iTree Streets software used for analysis, this threshold would allow conclusions to be drawn about the entire street tree population with a 10% standard error. A total of 1,150 street segments were identified within the city limits as potential study segments using Geographic Information Systems (GIS). GIS was then used to generate a geographically random sample of street segments for the inventory, which was checked to make certain each neighborhood was sufficiently represented in the study (Figure 2-1). In the end, 83 street segments were sampled throughout the course of the inventory, equivalent to approximately 7% of all street segments.

Figure 2-1. *Location of Forest Grove neighborhoods and randomly generated street segments.*



In many street tree inventories, a street tree is defined by its location in the planting strips between sidewalks and streets. This analysis used a more expansive definition of street tree. During the inventory process, a tree was classified as a street tree if it was located within planting spaces in street medians, planting strips between sidewalks and streets, or in yards (front, side, or rear) within 20-25 feet of the street. This expanded definition allowed a more detailed understanding of the composition of Forest Grove's urban forest resource, and a more complete picture of the diversity of the public and private trees which comprise the streetscapes in each neighborhood.

Street Tree Inventory

One, two-person team conducted the inventory from early January through early April 2011. A certified arborist was consulted with specific questions and accompanied the team on several spot checks as a form of quality control. The team collected a variety of field data in the course of completing the inventory, in addition to requisite city data and benefits prices necessary for the analysis with iTree Streets software (Table 2-1). Local values for Forest Grove were obtained for the price of electricity, natural gas, stormwater interception, and average home resale value, and default values provided by iTree Streets for the pacific northwest were used for the remaining benefits.

Table 2-1. *Data collected to describe the structure and function and evaluate the benefits of Forest Grove's street trees.*

Street Tree Inventory Data		
Field Data	Benefits Pricing	City Data
Street Address	Electricity ($/Kwh)	Total Municipal Budget
Street Segment	Natural Gas ($/therm)	Population
Neighborhood	Stormwater Interception ($/gal.)	Total Land Area
Detailed Location	Average Home Resale Value ($)	Total Linear Street Miles
Land Use	CO_2 ($/lb)	
Historic Tree or not	NO_2 ($/lb)	
DBH	PM_{10} ($/lb)	
Species	SO_2 ($/lb)	
Wood Condition	BVOC ($/lb)	
Wire Conflict		
Survey Date		
Comments		

Data Analysis

Field data was transferred to a master excel spreadsheet, which was checked thoroughly for errors, properly formatted, and converted to an access database. The city data and benefits prices shown in Figure 2-1 were entered into iTree Streets, and the list of tree species in the software was cross-checked with the field data to guarantee that all species inventoried were present and would be properly processed.

3 | Urban Forest Structure

Forest Structure

Forest Grove hosts a wide variety of tree types in the public and private spaces within its city limits (Table A-1). Based on the analysis performed in the course of this project, the street tree population is estimated at 27,419 trees of 158 different types. As described previously in this report, for the purposes of this analysis, 'street tree' refers to trees located in planting strips, road medians, or in yards (front, side, or rear) within 20-25 feet of the street. In spite of the diversity, just ten types (6.3%) comprise nearly half (46.3%) of the urban forest, leaving the majority of trees (93.7%) relatively underrepresented.

Table 3-1A. *Dominance and distribution of the five most abundant street tree types in Forest Grove. Numbers in parentheses indicate the percent of all trees in a given neighborhood.*

Rank	North Industrial	Old Town East	Safeway Central	Town Center	Old Town West	South Industrial	South Pacific
1st (%)	Oriental Arborvitae (10.5)	Northern White Cedar (24.4)	Japanese Maple (10.2)	Japanese Fl. Cherry (12.7)	Japanese Fl. Cherry (12.9)	Fremont Cottonwood (45.5)	Japanese Maple (15.5)
2nd (%)	European White Birch (7)	Japanese Fl. Cherry (12.6)	European White Birch (9.5)	Common Chokecherry (10.4)	Norway Maple (7.8)	Black Locust (27.3)	Japanese Fl. Cherry (8.3)
3rd (%)	Pacific Rhododendron (7)	Maple (11.8)	Pacific Dogwood (8.4)	Red Maple (6.4)	Maple (6.5)	Water Birch (9.1)	Norway Maple (8.2)
4th (%)	Quaking Aspen (6.3)	European White Birch (5.9)	Japanese Fl. Cherry (6.3)	Black Cherry (4.6)	Bamboo (5.1)	Black Hawthorn (9.1)	Pacific Dogwood (5)
5th (%)	Blue Spruce (4.9)	Vine Maple (4.2)	Norway Maple (5.3)	Norway Maple (4)	Japanese Maple (4.6)	Coast Redwood (9.1)	Douglas Fir (5)
# of Trees	1,913	1,592	1,271	2,314	2,902	147	2,421

The most abundant tree types found along streets in Forest Grove vary by neighborhood (Table 3-1A & 3-1B). Although japanese maple (*Acer palmatum*) is the most abundant tree city-wide, it is only the most common tree among four of the thirteen neighborhoods studied. Of the remaining nine neighborhoods, the most abundant tree type is either oriental arborvitae (*Thuja orientalis*), northern white cedar (*Thuja occidentalis*), japanese flowering cherry (*Prunus serrulata*), fremont cottonwood (*Populus fremontii*), or pacific bayberry (*Myrica californica*). None of the city's five most abundant species are widespread enough to be present among the top five species for every neighborhood. Japanese maple is the closest, among the five most abundant species in nine of the thirteen neighborhoods, while japanese flowering cherry is present in eight. It is important to note that due to the low number of roads in the South Industrial neighborhood, only one street segment was inventoried; the projection for the neighborhood presented here reflects only this street segment.

Table 3-1B. *Dominance and distribution of the five most abundant street tree types in Forest Grove. Numbers in parentheses indicate the percent of all trees in a given neighborhood.*

Rank	North Bypass	Merix Corner	West of Thatcher	High School	Lincoln Park	Goff Rd Farms	City Total
1st (%)	Japanese Fl. Cherry (15.8)	Japanese Maple (18.2)	Norway Maple (13)	Japanese Maple (14.2)	Pacific Bayberry (11.4)	Norway Maple (18.1)	**Japanese Maple (8.4)**
2nd (%)	Autumn Blaze Maple (12.9)	Rocky Mountain Maple (16)	Flowering Pear (10)	Norway Maple (8.8)	Norway Maple (8.7)	Japanese Maple (8.4)	**Japanese Fl. Cherry (8)**
3rd (%)	Northern White Cedar (11.5)	Japanese Fl. Cherry (15.9)	Japanese Maple (9.3)	European Linden (8.8)	Japanese Maple (8.2)	European White Birch (8.4)	**Norway Maple (6.7)**
4th (%)	Oregon White Oak (6.5)	Pacific Dogwood (11.4)	Douglas Fir (5.9)	Douglas Fir (6.9)	Flowering Pear (7.6)	Japanese Fl. Cherry (7.4)	**Northern White Cedar (5)**
5th (%)	Japanese Maple (5.8)	Kwanzan Cherry (11.4)	Pacific Dogwood (5.6)	Japanese Fl. Cherry (5.8)	Red Maple (4.9)	Flowering Pear (6)	**European White Birch (3.5)**
# of Trees	1,859	589	3,598	3,478	2,461	2,876	**27,419**

Table 3-2. *Species distribution of all street trees in Forest Grove.*

Species	Percent
Japanese Maple	8.4
Japanese Fl. Cherry	8.0
Norway Maple	6.7
Northern White Cedar	5.0
European White Birch	3.5
Red Maple	3.3
Pacific Dogwood	3.3
Douglas Fir	3.0
Flowering Pear	2.7
Maple	2.4
Oriental Arborvitae	2.2
Vine Maple	2.2
Black Cherry	1.8
BDS Other	1.7
Oregon Ash	1.5
Pacific Rhododendron	1.5
Oregon White Oak	1.4
European Linden	1.4
Western Red Cedar	1.2
Blue Spruce	1.1
Pacific Bayberry	1.0
Common Chokecherry	1.0
Silver Maple	0.9
Kwanzan Cherry	0.9
Autumn Blaze Maple	0.9
All Other Species	33.0
Total	**100.0**

The species distribution for the top twenty-five street trees in Forest Grove is illustrated in Table 3-2. With seven different species in the top twenty-five street trees, maples are by far the most ubiquitous tree in the study area, comprising nearly one-quarter (24.8%) of street trees city-wide. Cherry trees are the second most abundant street tree, with four species comprising nearly one-eight of all street trees (11.7%). Another popular street tree observed during the inventory is arborvitae, which were present as long privacy hedges or displayed as solitary ornamental pieces. These are identified as either northern white cedar or oriental arborvitae, and are estimated at 7.2% of the total street tree population.

Eleven of the top twenty-five trees are considered small trees at maturity, including japanese maple (*Acer palmatum*), japanese flowering cherry (*Prunus serrulata*), pacific dogwood (*Cornus nuttallii*), flowering pear (*Pyrus Aristocrats*), and pacific rhododendron (*Rhododendron macrophyllum*). The only tree species present in the top twenty-five which are classified as large trees at maturity are Douglas fir (*Pseudotsuga menziesii*), Oregon ash (*Fraxinus latifolia*), Oregon white oak (*Quercus garryana*), western red cedar (*Thuja plicata*), blue spruce (*Picea pungens*), and silver maple (*Acer saccharinum*). Please see Table A-1 (Appendix) for a complete population summary of all street trees in Forest Grove by functional tree type, species, and diameter at breast height (DBH).

Table 3-3. *Distribution of street trees by functional tree type (broadleaf, coniferous, deciduous, and evergreen), and mature tree size (small, medium, and large).*

Functional Tree Type	Trees (%)			
	Small	Medium	Large	Total
Broadleaf Deciduous	34.9	24.9	9.5	**69.3**
Broadleaf Evergreen	7.2	1.7	<.01	**8.9**
Coniferous Evergreen	2.4	8.8	11.5	**22.7**
Palm Evergreen	0.1	<.01	<.01	**0.1**
Total	**44.6**	**35.4**	**21**	

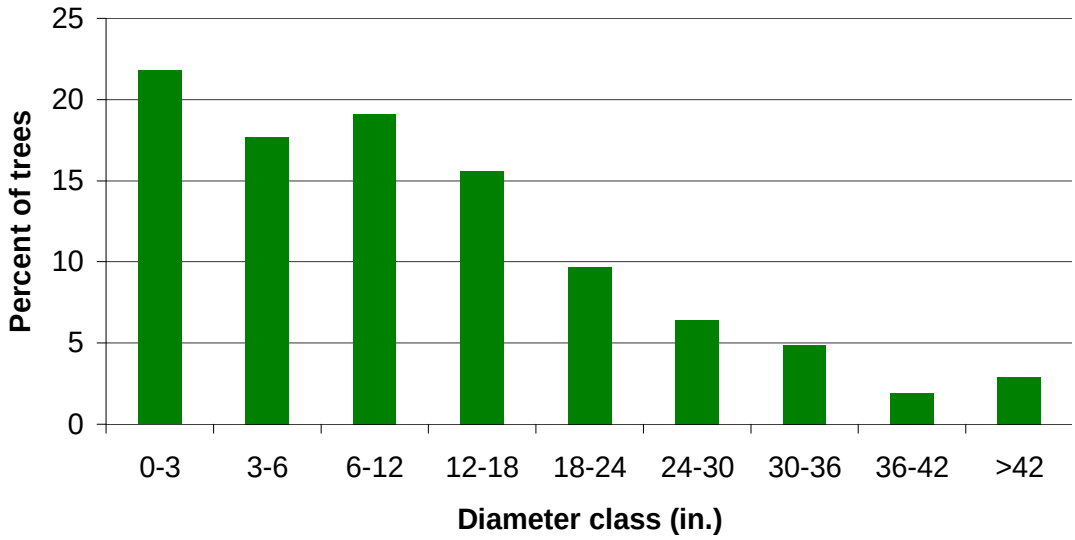
Broadleaf deciduous trees are the dominant tree type in Forest Grove, composing 69.3% of all street trees (Table 3-3). Coniferous evergreen trees represent 22.7% of the street trees, with broadleaf evergreen and palm evergreen accounting for the remaining 8.9% and 0.1%, respectively. Tree size in Table 3-3 reflects both the functional tree type and the mature tree size. Based on the random street segments sampled for this inventory, there is an uneven distribution of street trees by size throughout Forest Grove. Nearly 45% of all street trees are classified as small, 78% of which are broadleaf deciduous. Although large trees account for just 21% of all street trees, 54.9% are coniferous evergreen.

The top three most abundant street trees in Forest Grove. Clockwise from top left: japanese maple, norway maple, and japanese flowering cherry.

Tree Dimensions and Characteristics

As trees grow, they tend to increase in diameter. Although an imperfect measure, the diameter at breast height (DBH) can be used to estimate relative tree age. Understanding the relative ages of trees in each diameter range can provide valuable insight into urban forest management. For example, an even distribution of young, maturing, and mature trees is desirable for maintenance and replacement costs in the long run. It also limits the impacts of eventual replacement on canopy coverage and population diversity.

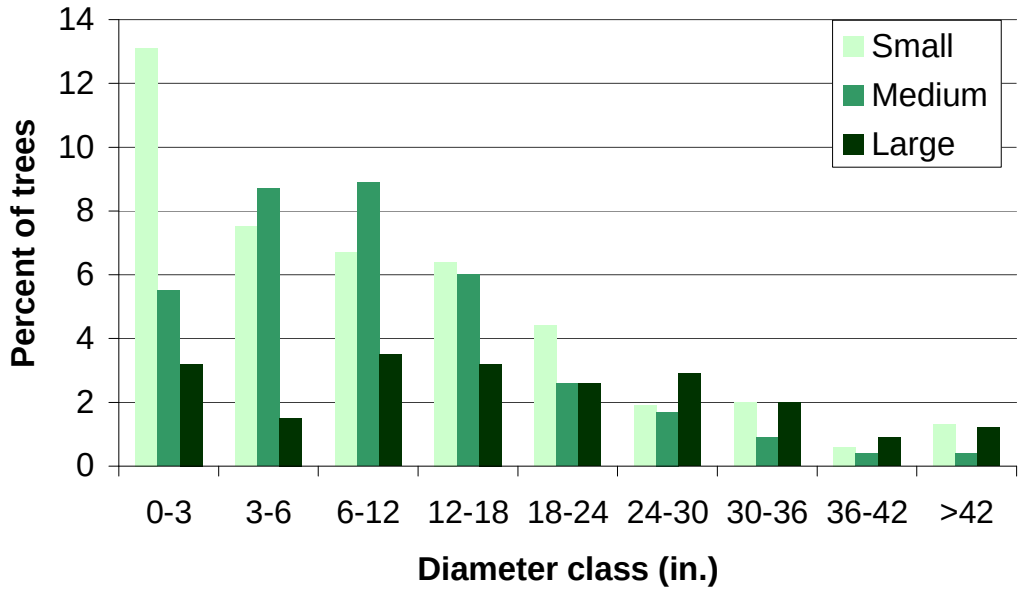
Figure 3-1. *Percentage of street trees in each diameter class.*



Forest Grove's urban forest hosts a diversity of tree sizes, from newly planted seedlings to magnificent specimens with diameters exceeding 3½ feet (Figure 3-1, Table A-1). Greater than half (58.9%) of the street trees are 12" DBH or less, and fewer than 10% are larger than 30" DBH. It is important to remember that while larger trees are generally older, a 6" Hawthorn is likely to be more mature than a 6" Douglas fir. Therefore care should be taken when estimating the relative age of the entire population from these results.

New patterns emerge upon further manipulation of the proportion small, medium, and large street trees in each diameter class throughout Forest Grove (Figure 3-2). As might be predicted, small trees outnumber medium and large trees combined in the 0-3 inch diameter class. Small and medium trees with diameters within the three diameter classes from 3 to 18 inches represent from 6 – 9% of street trees per size, per diameter class. Large trees are the most abundant in diameter classes greater than 24 inches. It is important to note that the methods employed for measuring the DBH of trees with multiple trunks for the purposes of this analysis likely led to an over-representation of small and medium trees in diameter classes 18 inches and greater.

Figure 3-2. *Proportion of small, medium, and large trees at maturity in each diameter class.*



Canopy Coverage

Canopy coverage is the ground surface area covered by the tree canopy, and represents an important measure of the urban forest's benefit potential. The greater the area of the leaf canopy, the larger the tree and the greater the benefits it provides. It is estimated that 350 acres, corresponding to 10% of the total land area in Forest Grove, are covered by the street tree canopy (Table 3-4).

Table 3-4. *Canopy coverage of street trees in Forest Grove (acres).*

	Total Land Area	Total Canopy Cover	Canopy Cover as % of Total Land Area
City Total	3,456	350	10.14

Over half (55.7%) of the canopy coverage provided by street trees in Forest Grove exists in five neighborhoods: High School, South Pacific, Town Center, West of Thatcher, and Old Town West (Table 3-5). Although neighborhoods with comparatively higher numbers of street segments sampled for the inventory tend to be overrepresented and have higher canopy cover acreage totals than neighborhoods with less street segments inventoried, underrepresentation due to the random sampling process does not preclude a high percentage of canopy cover. For example, South Pacific had just five street segments inventoried, yet is projected at 10% of total street tree canopy. Conversely, ten street segments were inventoried in North Bypass, but it is projected at just 4.9% of total street tree canopy. The type and size of tree are clearly an important determining factor in tree canopy coverage.

Table 3-5. *Canopy coverage of street trees in Forest Grove by neighborhood (acres).*

Zone	Canopy Cover	% of Total Canopy
North Industrial	34	9.6
Old Town East	21	6.1
Safeway Central	19	5.4
Town Center	39	11.1
Old Town West	47	13.4
South Industrial	6	1.7
South Pacific	35	10.0
North Bypass	17	4.9
Merix Corner	4	1.2
West of Thatcher	39	11.2
High School	35	10.0
Lincoln Park	25	7.1
Goff Rd Farms	29	8.4
City Total	**350**	**100.0**

4| Asset Management

Tree Replacement Values

Replacement value is the cost of replacing a tree with another of equivalent species, size, and condition in the same location. The dollar value is determined from cross-sectional trunk area and species (basic value), and the condition and location (value ranking). Forest Grove's street trees are valued at approximately $148,273,010, or $5,400 per tree (Table 4-1A and Table 4-1B).

Table 4-1A. *Replacement value of Forest Grove's street tree resource by DBH class and neighborhood (dollars).*

DBH (in.)	North Industrial	Old Town East	Safeway Central	Town Center	Old Town West	South Industrial	South Pacific
0-3	20,308	40,734	30,664	34,166	97,133	0	54,141
3-6	49,164	289,408	123,214	151,298	247,570	0	207,330
6-12	606,242	110,784	318,587	958,138	753,976	11,099	597,148
12-18	1,426,859	833,858	957,676	1,580,474	2,477,241	40,074	1,862,844
18-24	1,628,559	1,196,735	940,313	2,350,874	2,038,420	0	2,935,244
24-30	2,714,862	1,807,784	1,688,420	1,836,870	3,397,476	356,326	3,714,297
30-36	4,122,512	1,745,792	1,667,992	3,191,216	3,249,712	333,017	3,757,851
36-42	889,171	1,051,902	767,212	3,454,521	1,883,211	482,979	1,008,930
>42	4,644,412	4,506,712	3,115,841	4,732,011	2,922,045	1,962,431	3,354,549
Total	16,102,088	11,583,710	9,609,919	18,289,568	17,066,785	3,185,926	17,492,334

Table 4-1B. *Replacement value of Forest Grove's street tree resource by DBH class and neighborhood (dollars).*

DBH (in.)	North Bypass	Merix Corner	West of Thatcher	High School	Lincoln Park	Goff Rd Farms	City Total
0-3	136,387	30,161	140,219	159,947	142,611	56,104	942,575
3-6	107,046	39,330	343,474	325,609	142,276	302,893	2,238,613
6-12	463,199	231,051	1,309,751	984,606	589,994	1,192,893	8,127,469
12-18	458,933	382,870	3,059,530	1,035,470	1,854,959	2,392,841	18,363,630
18-24	1,256,667	572,672	3,092,432	3,013,971	899,489	1,479,666	21,405,042
24-30	1,492,547	0	3,122,005	2,567,850	2,398,293	178,326	25,275,057
30-36	1,222,448	0	937,664	4,293,577	1,519,001	1,113,451	27,154,233
36-42	1,381,411	0	1,547,159	511,995	2,569,397	1,181,804	16,729,692
>42	255,621	0	929,401	1,070,091	0	453,587	27,946,700
Total	6,774,259	1,256,085	14,481,635	13,963,117	10,116,022	8,351,565	148,273,010

The top ten most abundant street trees account for 32% of the total replacement value of Forest Grove's street trees, which is equivalent to approximately $47,413,000 (Table A-2). Other species possessing significant replacement value include Oregon white oak (*Quercus garryana*) at $7.4 million, giant sequoia (*Sequoiadendron giganteum*) at $5.8 million, western red cedar (*Thuja plicata*) at $4.4 million, deodar cedar (*Cedrus deodara*) at $2.8 million, and silver maple (*Acer saccharinum*) at $2.3 million.

5 | Benefits of Trees

Environmental Services & Aesthetic Benefits

Forest Grove's street trees provide quantifiable environmental services and aesthetic benefits to the local community. For the purposes of this analysis with iTree Streets software, environmental services are quantified using the market value of the service provided or the cost avoided. Although aesthetic benefits are often difficult to quantify, such as softening hard building edges of an urban cityscape, iTree Streets software uses the increase of property values associated with the presence of trees to approximate this value.

Trees lower atmospheric pollution by storing and sequestering CO_2 and other pollutants, thereby improving overall air quality. The urban forest also reduces the burden on stormwater infrastructure through both the retention of rain droplets within the tree canopy and the interception of surface and ground flow through root systems. Buildings receive shade from the tree canopy throughout the day, which reduces overall energy demand and contributes to lower pollutant emissions. The urban forest also provides an important habitat for wildlife, beautifies the streetscape, and contributes to a strong sense of place. Forest Grove's street trees provide over $2 million in environmental services and aesthetic benefits per year (Table 5-1).

Table 5-1. *Valuation of the environmental services and aesthetic benefits provided annually by Forest Grove's street trees.*

Benefits	Total ($)	$/tree	$/person
Energy Savings	68,920	2.51	3.27
Carbon Sequestration	25,990	0.95	1.23
Air Quality Improvement	46,289	1.69	2.20
Stormwater Processing	671,717	24.50	31.86
Aesthetics	1,246,019	45.44	59.10
Total Benefits	**2,058,935**	**75.09**	**97.66**

Forest Grove's street trees provide more than $72 thousand in air quality improvement and carbon sequestration services per year. This is equivalent to the removal of nearly 8 million pounds of ozone, nitrogen dioxide, particulate matter 10 microns, sulfur dioxide, and carbon dioxide annually from the air in Forest Grove (Table 5-2).

Stormwater infrastructure in Forest Grove is relieved annually of processing more than 24 million gallons of stormwater which is intercepted by street trees. This represents an estimated savings of over $671 thousand per year, equivalent to $31 per person.

The mitigation of temperature extremes through shading and wind calming lower electricity and natural gas demand, which results in annual savings of nearly 1,000 MWh of electricity and over 28,000 therms of natural gas. Forest Grove residents save close to $69,000 per year in avoided energy costs.

Street trees in Forest Grove also contribute to increased average resale values and enhance the city's attractiveness to homebuyers, renters, and visitors. Forest Grove's street trees provide one and a

half times more aesthetic benefits than environmental benefits combined, worth more than $1.2 million in property resale value per year.

Table 5-2. *Annual environmental benefits and carbon storage provided by Forest Grove's Street Trees.*

Benefits	Total	per tree	per person
Electricity (MWh)	988	<0.1	<0.1
Natural Gas (Therms)	28,868	1	1
Stormwater (gallons)	24,248,042	884	1,150
Annual Carbon (lbs)	7,875,632	287	374
Air Pollutants (lbs)	32,130	1	2
Stored Carbon (lbs)	130,765,973	4769	6202

The value of per tree benefits provided depends on the species and size at maturity. A large tree has a larger canopy, root system, and trunk diameter than a small tree, and therefore possesses a greater capacity to provide benefits. An urban forest composed of larger trees at maturity will thus confer greater environmental services and aesthetic benefits than one composed of trees which are smaller at maturity. The difference between the benefits accrued by small and large trees is illustrated in Table 5-3. Less than one third of the 22 most abundant street trees in Forest Grove is a large tree at maturity; just one large tree (Douglas fir) is present in the top ten. The difference in total benefits between a small tree, such as Northern White Cedar ($9/tree, 4th most abundant species citywide), compared to a large tree such as Blue Spruce ($119/tree, 20th most abundant), is substantial.

Table 5-3. *Average annual environmental and aesthetic benefits per tree (dollars) by Forest Grove's 22 most abundant street tree species. Letters in parentheses represent mature tree size: S = small, M = medium, L = large.*

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetics	Total
Japanese Maple (M)	1.82	0.55	1.20	16.09	50.37	70.03
Japanese Fl. Cherry (S)	1.59	1.79	1.13	9.64	32.26	46.41
Norway Maple (M)	2.95	0.91	1.86	24.15	71.70	101.57
Northern White Cedar (M)	0.08	0.13	0.12	2.12	6.86	9.31
European White Birch (M)	2.60	0.42	1.66	21.01	44.14	69.83
Red Maple (M)	2.75	0.61	1.68	18.29	60.67	84.00
Pacific Dogwood (S)	1.06	1.17	0.75	6.63	21.06	30.68
Douglas Fir (L)	5.35	1.25	3.50	76.56	91.14	180.79
Flowering Pear (S)	3.18	0.93	2.52	24.25	28.16	59.05
Maple (M)	2.10	0.67	1.34	17.96	60.79	82.87
Oriental Arborvitae (M)	0.11	0.27	0.18	3.33	11.13	15.02
Vine Maple (M)	4.23	1.24	2.86	38.97	67.37	114.66
Black Cherry (S)	2.22	2.22	1.57	12.81	44.72	63.55
BDS Other (S)	0.97	1.08	0.72	7.37	14.64	24.79
Oregon Ash (L)	1.97	0.79	1.54	19.04	59.42	82.77
Pacific Rhododendron (S)	4.55	0.96	3.87	42.77	19.43	71.58
Oregon White Oak (L)	9.48	2.39	6.61	111.36	119.27	249.12
European Linden (L)	1.64	0.55	1.07	15.28	29.42	47.96
Western Red Cedar (L)	4.85	1.08	3.21	72.90	84.16	166.19
Blue Spruce (L)	2.97	0.74	2.10	37.86	75.61	119.28
Pacific Bayberry (S)	0.16	0.05	0.09	1.87	22.55	24.73
Common Chokecherry (S)	1.50	1.25	1.01	7.81	31.01	42.59

The top ten most abundant street tree species constitute nearly half (46.3%) of Forest Grove's urban forest, and account for a similar percentage (42.6%) of the total annual environmental and aesthetic benefits (Table 5-4). The presence of a large number of small trees in the top ten accounts for this difference in representation. Abundant trees such as northern white cedar (0.6% of total benefits) or pacific dogwood (1.3% of total benefits) do not provide environmental services and aesthetic benefits to nearly the extent as do less abundant, but larger trees such as Oregon white oak (4.7% of total benefits) or western red cedar (2.7% of total benefits).

Table 5-4. *Total annual environmental and aesthetic benefits of street trees by species (dollars).*

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetics	Total	% of Total $
Japanese Maple	4,198	1,267	2,764	37,004	115,866	161,098	7.8
Japanese Fl. Cherry	3,487	3,934	2,483	21,148	70,759	101,810	4.9
Norway Maple	5,448	1,679	3,432	44,569	132,341	187,468	9.1
Northern White Cedar	111	177	172	2,917	9,453	12,830	0.6
European White Birch	2,505	406	1,600	20,231	42,505	67,247	3.3
Red Maple	2,462	546	1,504	16,394	54,365	75,270	3.7
Pacific Dogwood	952	1,051	675	5,943	18,871	27,493	1.3
Douglas Fir	4,364	1,016	2,852	64,909	74,361	147,503	7.2
Flowering Pear	2,384	699	1,886	18,166	21,092	44,227	2.1
Maple	1,378	437	880	11,771	39,842	54,309	2.6
Oriental Arborvitae	68	167	109	2,052	6,846	9,243	0.4
Vine Maple	2,546	747	1,722	23,452	40,545	69,013	3.4
Black Cherry	1,100	1,099	775	6,341	22,133	31,448	1.5
BDS Other	441	492	329	3,350	6,659	11,272	0.5
Oregon Ash	792	317	619	7,641	23,841	33,211	1.6
Pacific Rhododendron	1,825	385	1,553	17,161	7,795	28,720	1.4
Oregon White Oak	3,678	928	2,566	43,193	46,262	96,627	4.7
European Linden	635	212	413	5,929	11,413	18,602	0.9
Western Red Cedar	1,621	361	1,073	24,376	28,141	55,571	2.7
Blue Spruce	915	226	646	11,646	23,260	36,694	1.8
Pacific Bayberry	45	15	27	526	6,333	6,945	0.3
Common Chokecherry	422	351	285	2,193	8,711	11,963	0.6
All Other Species	27,542	9,475	17,925	280,804	434,626	770,372	37.4
City Wide Total	68,920	25,990	46,289	671,717	1,246,019	2,058,936	100.0

The annual value of total environmental services and aesthetic benefits per tree varies by neighborhood from a minimum of $51 in Merix Corner to a high of $135 in South Industrial (Table 5-5). As the next highest annual benefit per tree is $87 in North Industrial, the value for South Industrial is significantly higher, which is due to the low sample size of street segments. This led to an overrepresentation of the tree types that were inventoried, which were primarily large Fremont cottonwood (*Populus fremontii*) and black locust (*Robinia pseudoacacia*). Although the low annual benefit per tree in Merix Corner could also reflect the low sample size of street segments in that neighborhood, this is not likely a correct interpretation, as the annual benefit per tree in North Bypass, which had the second highest number of street segments sampled for this analysis, is $55.

Table 5-5. *Total annual environmental and aesthetic benefits of street trees by neighborhood (dollars).*

Neighborhood	Energy	CO_2	Air Quality	Stormwater	Aesthetics	Total
North Industrial	3.35	0.97	2.36	34.46	46.35	87.47
Old Town East	2.66	0.90	1.70	30.27	41.18	76.71
Safeway Central	3.01	1.13	1.84	29.47	45.58	81.03
Town Center	3.17	1.36	2.15	30.18	46.36	83.22
Old Town West	3.09	1.11	2.06	29.01	50.51	85.78
South Industrial	7.64	1.31	4.68	82.49	38.84	134.96
South Pacific	2.85	1.18	1.94	28.38	47.18	81.54
North Bypass	1.67	0.78	1.16	16.40	35.07	55.09
Merix Corner	1.56	0.61	0.93	11.34	36.56	50.99
West of Thatcher	2.22	0.72	1.50	22.48	49.38	76.31
High School	2.01	0.80	1.35	19.97	43.89	68.02
Lincoln Park	1.99	0.93	1.41	18.06	40.34	62.72
Goff Rd Farms	2.15	0.82	1.43	18.57	50.02	72.99

6 | Implications

Street Tree Canopy Composition

Forest Grove's street tree resource consists of multiple species, sizes, and ages valued at approximately $151 million that generates more than $2 million in environmental services and aesthetic benefits per year. Pedestrians, cyclists, and drivers travelling in Forest Grove enjoy a streetscape enhanced by 27,419 street trees of 158 different types. Although a large number of different trees are present along Forest Grove's streets, a comparatively small number constitute the majority of the resource. Only ten types (6.3%) comprise nearly half (46.3%) of the urban forest, leaving the majority of trees (93.7%) relatively underrepresented. Nearly a quarter of all street trees belong to three tree types: japanese maple (*Acer palmatum*), japanese flowering cherry (*Prunus serrulata*), and norway maple (*Acer platanoides*).

Street Tree Investment

Investing in street trees provides many benefits. Street trees create a more beautiful and inviting cityscape for residents and visitors to Forest Grove alike. They also reduce overall energy demand, enhance ambient air quality, reduce the burden on stormwater processing infrastructure, reduce the level of CO_2 in the atmosphere, and increase property resale values. These benefits enhance the quality of life and contribute to the sustainability of the community. As the street trees in Forest Grove's urban forest mature, they will appreciate in structural value and provide a steadily increasing level of environmental services and aesthetic benefits.

Street Tree Management

In order to maximize the environmental services and aesthetic benefits that each tree in Forest Grove is capable of providing, the first step is to maintain the health of the existing street trees through effective, proactive forest management practices. Efforts should continue to retain current canopy coverage and maintain street tree health in order to ensure the current level of benefits provided persists. Future planting opportunities are important moments to consider the impact of each new tree selection and placement on the overall composition and function of Forest Grove's urban forest. Environmental services and aesthetic benefits provided by planting as large a tree as possible, and ensuring new trees are planted in the right place. A small, decorative tree in a location suitable for a larger species represents a substantial loss of potential benefits, as does a tree planted in a location which does not allow it to grow to fully provide the benefits it could in a more suitable location. Although neither a right tree/right place analysis nor a planter width inventory was conducted for the purposes of this analysis, the prevalence of small trees within the top 25 most abundant species suggests that Forest Grove is saving less energy, removing fewer air pollutants, storing less CO_2, intercepting less stormwater, and realizing smaller increases in property resale values than it could with larger species. A proactive tree planting strategy, with intentional tree selection and placement, could earn higher benefits for future generations compared to a planting regimen that perpetuated the existing street tree composition.

7 | Recommendations

Continue Tree Inventory and Analysis

Conducting a street tree inventory and determining ecosystem services and benefits with iTree Streets software is perhaps one of the best, low-cost methods available to municipalities and community organizations to understand the structure, composition, and condition of an entire urban forest. By quantifying the many benefits street trees confer upon the community, their value as a resource can be more fully understood by the City and its citizens, and current and future forest management and planting strategies can be better informed and adapted to maximize future benefits. Continuing to conduct the tree inventory upon which this report is based would yield a more comprehensive and accurate portrait of Forest Grove's street trees, and lend greater weight to prioritization of maintenance and planting strategies. Alternatively, future tree inventories and analyses could consist of complete inventories focused on particular study areas of interest to the City or Forestry Commission, or target a specific neighborhood for analysis. Regardless of the type of inventory selected, it will be important to consider the following:

- **Conduct the inventory during the "leaf-on" season.** Identifying trees during the winter is possible, but time-consuming with a greater likelihood of introducing error into the analysis. Furthermore, the poor weather will hinder any efforts to involve volunteers.

- **Standardize technique for measuring DBH of trees with multiple trunks.** Be sure to measure the DBH of trees with multiple trunks by finding the sum of each individual trunk, rather than measuring the overall space created by the trunk structure. If the latter technique is used, the entire DBH, even though it contains spaces between the trunks, will be interpreted by iTree Streets software as one large trunk. Many ecosystem services, such as the amount carbon stored and removed annually, will be overestimated as a result. Furthermore, small and medium trees in larger diameter classes will be overestimated and portray an inaccurate projection of these species' size and age.

- **Be aware of small sample sizes from neighborhoods.** While the process for generating random street segments for a sample inventory in GIS is effective, care should be taken when the study area is divided into zones, or neighborhoods, as in this report. Even though the number of street segments in Forest Grove ranges from as few as 13 (South Industrial) to a high of 166 (High School), a randomly generated set of street segments may not include a sufficient number in certain neighborhoods to create accurate projections for that neighborhood. It may be necessary to strategically edit the randomly generated list of street segments to ensure each zone or neighborhood has a certain threshold of segments. Should criteria be suggested (e.g., equal proportion of linear feet by neighborhood, equal proportion of street segments per neighborhood)?

- **Condition estimation.** It is important to consult with either a Certified Arborist or members of the Forestry Commission to ensure that street tree field teams are noting the condition of foliage and wood in a manner consistent with the City's preference. The replacement value and capacity to provide environmental services can be grossly overestimated if trees are listed in better condition than they actually are.

- **Involve the Forestry Commission and Professionals.** Future tree inventories and analyses will best serve the interests of the City and citizens if members of the Forestry Commission are intimately involved with the study design and collection of field data. Involving professionals will also aid in tree identification and refining data collection procedures.

- **Right Tree/Right Place.** It is recommended that future inventories include a right tree/right place analysis, which will entail collecting information on overhead wire conflicts, planting space width, DBH, and tree height. Results will indicate the percentage of the urban forest placed in inappropriate locations, and the corresponding lost benefits.

- **Stocking Levels.** Understanding the percentage of potential planting spaces in the street right-of-way currently occupied by trees would be an extremely useful urban forest management tool. It would identify both the number of planting spaces available by zone and which were planted with trees, thus allowing the City to direct strategic investments and planting efforts to areas with the lowest stocking levels.

Engage the Community

The Community Forestry Commission and the Neighborwoods program are already engaging Forest Grove in meaningful ways in the care and stewardship of the urban forest. It is recommended that the City build on these successful efforts and initiatives and involve community volunteers in a tree inventory. This would provide yet another way to connect citizens with the natural environment right in their backyard, and would provide a valuable way for participants to learn about the ecosystem services and benefits that an urban forest full of healthy trees planted in the correct spaces and effectively cared for is capable of providing. Plus, using volunteers would allow more field data to be collected over a shorter period of time.

Monitor Forest Management Costs

A useful component of iTree Streets software is the ability to include figures for the assortment of annual costs incurred by the City in the course of managing the urban forest. Inputting information for the annual costs of planting, pruning, pest and disease control, stump removal and disposal, irrigation, and others allows the net benefits to the community to be calculated. Since annual costs are not currently available from Forest Grove for these activities, only the gross benefits from street trees were able to be calculated for this report. It is recommended that the City begin to monitor these annual expenses not only for the inherent benefit which sound accounting practices create, but also to determine what the dollar return from the urban forest is for every dollar invested in it.

Re-evaluate Recommended Street Tree List

Finally, it is hoped that the results contained within this report will generate dialogue among City staff and Forestry Commission members regarding Forest Grove's recommended list of street trees. The difference in the benefits created by smaller trees (e.g., oriental arborvitae) compared to those generated by larger trees (e.g., Oregon white oak) are considerable (Table 5-3). While many of the smaller trees recommended for street planting are quite showy and visually striking, it is recommended that the expenditure of limited and valuable City resources be instead directed toward trees which will grow larger and have the potential to create far more benefits over the course of

their life time. While not every planting space can accept a large tree, every effort should be made to plant the largest tree as is reasonable for the conditions. The City may also consider offering subsidies for trees which confer the greatest benefits to citizens purchasing trees to plant in the street.

Table A-1. *Relative number of street trees by functional tree type, species, and DBH class.*

Key:
Broadleaf Deciduous Small/Medium/Large: BDS/M/L
Broadleaf Evergreen Small/Medium/Large: BES/M/L
Conifer Evergreen Small/Medium/Large: CES/M/L
Palm Evergreen Small/Medium/Large: PES/M/L

Tree Type	DBH (in.)									
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total
Oregon Ash	13	107	187	27	27	40	0	0	0	401
Oregon White Oak	54	0	13	0	40	134	40	94	13	388
European Linden	241	27	67	0	0	0	40	0	13	388
Silver Maple	27	13	80	0	54	27	40	13	0	254
Japanese Zelkova	120	0	54	40	13	0	0	0	0	227
Ginkgo	134	0	0	13	0	0	0	0	0	147
Bigleaf Maple	0	13	0	27	27	27	27	0	13	134
American Elm	0	0	13	13	13	13	67	13	0	134
Tulip Tree	13	0	0	27	13	40	13	13	0	120
European Beech	13	0	40	0	0	27	0	0	0	80
Fremont Cottonwood	0	0	0	0	0	13	13	0	40	67
Scarlet Oak	54	13	0	0	0	0	0	0	0	67
Northern Catalpa	0	0	0	27	0	13	0	0	0	40
Northern Red Oak	0	0	40	0	0	0	0	0	0	40
European Ash	0	0	13	13	0	0	0	0	0	27
California Black Oak	0	13	0	0	0	0	13	0	0	27
Boxelder	0	0	0	13	0	0	0	0	0	13
Spaeth European Beech	13	0	0	0	0	0	0	0	0	13
London Planetree	0	0	0	0	0	0	13	0	0	13
White Oak	0	0	13	0	0	0	0	0	0	13
BDL Total	**682**	**187**	**522**	**201**	**187**	**334**	**268**	**134**	**80**	**2,595**

Tree Type	DBH (in.)									
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total
Norway Maple	174	482	495	441	161	67	27	0	0	1,846
European White Birch	94	120	254	268	94	107	0	27	0	963
Red Maple	161	187	294	187	54	0	13	0	0	896
Maple	120	308	80	80	13	27	27	0	0	655
Autumn Blaze Maple	241	0	0	0	0	0	0	0	0	241
Norway Maple 'Schwedler'	0	0	107	94	27	0	0	0	0	227
Red Alder	67	94	0	0	13	13	0	0	0	187
Rocky Mountain Maple	0	13	54	80	13	0	0	0	0	161
Sweetgum	0	0	54	54	40	13	0	0	0	161
Common Plum	40	0	80	13	0	0	0	0	0	134
Quaking Aspen	0	0	120	0	0	0	0	0	0	120
Littleleaf Linden	0	107	13	0	0	0	0	0	0	120
Paper Birch	54	40	13	0	0	0	0	0	0	107
Corkscrew Willow	27	13	27	40	0	0	0	0	0	107
Eastern Redbud	67	13	13	0	0	0	0	0	0	94
Black Locust	0	0	13	0	0	13	0	40	27	94
English Walnut	0	0	0	13	0	27	0	0	27	67
Royal Paulownia	0	13	0	13	0	13	27	0	0	67
Sweet Cherry	0	54	13	0	0	0	0	0	0	67
Weeping Willow	13	0	0	0	0	27	0	0	27	67
BDM Other	0	0	13	0	13	0	13	0	0	40
Katsura Tree	13	0	0	27	0	0	0	0	0	40
Singleleaf Ash	0	0	0	13	13	0	0	0	13	40
Jerusalem-thorn	13	0	0	0	0	27	0	0	0	40
Common Pear	27	0	13	0	0	0	0	0	0	40
State Street Miyabe Maple	27	0	0	0	0	0	0	0	0	27
Sycamore Maple	0	0	0	0	13	13	0	0	0	27
Water Birch	0	0	13	0	0	13	0	0	0	27
Northern California Walnut	0	0	0	27	0	0	0	0	0	27
Bebb Willow	27	0	0	0	0	0	0	0	0	27
Pacific Willow	13	0	0	0	0	13	0	0	0	27
Mimosa	0	0	0	13	0	0	0	0	0	13
River birch	0	0	0	13	0	0	0	0	0	13
Buttonbush	13	0	0	0	0	0	0	0	0	13
Japanese Persimmon	0	13	0	0	0	0	0	0	0	13
Eucalyptus	0	0	0	0	13	0	0	0	0	13
American Hophornbeam	0	0	0	0	13	0	0	0	0	13
Chinese Apricot	13	0	0	0	0	0	0	0	0	13
BDM Total	**1,204**	**1,458**	**1,672**	**1,378**	**482**	**375**	**107**	**67**	**94**	**6,835**

Tree Type	DBH (in.)									
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total
Japanese Maple	1,364	308	161	107	174	94	67	0	27	2,301
Japanese Fl. Cherry	548	482	334	415	161	147	80	27	0	2,194
Pacific Dogwood	428	147	174	13	40	54	227	0	13	896
Vine Maple	40	120	147	134	40	13	40	40	27	602
Black Cherry	0	80	120	107	174	13	0	0	0	495
BDS Other	254	120	27	0	0	0	0	13	40	455
Common Chokecherry	27	13	147	67	27	0	0	0	0	281
Kwanzan Cherry	40	40	67	67	27	13	0	0	0	254
Cherry Plum	27	67	0	13	13	27	67	13	13	241
Chinese (Saucer) Magnolia	27	27	80	0	13	40	13	0	0	201
Apple Tree	27	13	27	27	40	0	13	13	0	161
European Mountain Ash	13	27	54	13	13	0	0	0	0	120
Camperdown Elm	67	13	40	0	0	0	0	0	0	120
Bitter Cherry	0	27	54	27	0	0	0	0	0	107
Pussy Willow	0	40	13	27	27	0	0	0	0	107
Oregon Crab Apple	0	27	0	13	40	0	13	0	0	94
American Hazelnut	0	13	27	0	13	0	0	0	27	80
Oneseed Hawthorn	27	0	0	27	13	0	0	0	0	67
Mahaleb Cherry	0	27	0	13	13	13	0	0	0	67
Greene Mountain-ash	0	0	0	13	54	0	0	0	0	67
Black Hawthorn	0	0	13	40	0	0	0	0	0	54
Japanese Snowbell	40	0	0	0	0	0	13	0	0	54
Common Crabapple	0	0	27	13	0	0	0	0	0	40
Sargent Cherry	13	13	13	0	0	0	0	0	0	40
Higan Cherry	27	13	0	0	0	0	0	0	0	40
Smooth Sumac	0	0	0	0	13	13	0	0	13	40
Cascara Buckthorn	0	27	13	0	0	0	0	0	0	40
Golden Chain Tree	227	0	0	0	0	0	0	0	0	27
Birchbark Cherry	0	13	13	0	0	0	0	0	0	27
Veitch Hawthorn Maple	0	0	0	0	13	0	0	0	0	13
Speckled Alder	13	0	0	0	0	0	0	0	0	13
Common Hazel	0	0	0	0	0	0	0	13	0	13
Columbia Hawthorn	0	0	0	0	13	0	0	0	0	13
Crapemyrtle	13	0	0	0	0	0	0	0	0	13
Japanese Fl. Crabapple	0	13	0	0	0	0	0	0	0	13
Mesabi Cherry	13	0	0	0	0	0	0	0	0	13
Pin Cherry	0	0	13	0	0	0	0	0	0	13
Rose	0	0	0	0	0	0	13	0	0	13
Common Lilac	0	0	0	13	0	0	0	0	0	13
BDS Total	**3,036**	**1,672**	**1,565**	**1,150**	**923**	**428**	**348**	**120**	**161**	**9,403**

Tree Type	DBH (in.)									
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total
BEL Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Tree Type	DBH (in.)									
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total
Bamboo	80	0	54	13	0	0	0	0	0	147
American Holly	27	13	27	0	0	0	0	0	0	67
Toyon	0	0	0	0	13	13	0	0	0	27
Catalina Cherry	0	13	0	0	13	0	0	0	0	27
Laurel Sumac	0	0	0	13	0	0	13	0	0	27
California Laurel	0	0	0	0	0	13	13	0	0	27
BEM Other	0	0	13	0	0	0	0	0	0	27
Athel Tamarisk	0	0	0	0	13	0	0	0	0	13
BEM Total	**107**	**27**	**94**	**27**	**40**	**27**	**27**	**0**	**0**	**348**

Tree Type	DBH (in.)									
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total
Flowering Pear	80	67	120	415	54	13	0	0	0	749
Pacific Rhododendron	27	27	27	0	120	27	120	27	27	401
Pacific Bayberry	281	0	0	0	0	0	0	0	0	281
BES Other	0	107	27	0	0	0	0	13	27	174
English Holly	0	27	0	54	13	13	13	0	0	120
Japanese Camellia	40	0	0	0	13	0	27	0	27	107
Southern Magnolia	27	0	27	0	0	0	0	0	13	67
Fraser Photinia	0	0	13	0	27	0	27	0	0	67
Australian Laurel	0	0	0	13	0	0	0	0	0	13
BES Total	**455**	**227**	**214**	**482**	**227**	**54**	**187**	**40**	**94**	**1,980**

Tree Type	DBH (in.)									
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total
Douglas Fir	54	13	80	80	187	214	120	67	0	816
Western Red Cedar	13	0	67	67	54	54	40	13	27	334
Blue Spruce	54	13	27	120	80	13	0	0	0	308
Western White Pine	27	0	0	80	40	27	0	0	13	187
Deodar Cedar	0	0	13	40	54	27	13	0	27	174
Port Orford Cedar	0	13	54	0	27	27	13	0	13	147
Giant Sequoia	0	0	0	0	0	0	0	0	120	120
Cedar of Lebanon	13	13	13	67	0	0	0	13	0	120
Engelmann Spruce	13	0	40	54	0	0	13	0	0	120
Noble Fir	13	13	27	40	0	0	0	0	0	94
Brewer Spruce	0	13	0	0	13	40	0	13	13	94
Atlas Cedar	0	27	54	0	0	0	0	0	0	80
Scotch Pine	0	0	27	27	0	0	27	0	0	80
Western Hemlock	0	54	0	0	13	13	0	0	0	80
Monkey Puzzle Tree	13	0	0	13	27	0	0	0	0	54
Alaska Cedar	0	27	0	0	0	27	0	0	0	54
White Spruce	0	0	27	13	13	0	0	0	0	54
Pacific Silver Fir	0	13	13	0	0	13	0	0	0	40
Norway Spruce	0	0	0	13	0	0	13	0	0	27
Knobcone Pine	0	13	0	0	13	0	0	0	0	27
Sugar Pine	0	0	0	13	0	0	0	13	0	27
Ponderosa Pine	0	13	0	13	0	0	0	0	0	27
Coast Redwood	0	0	0	0	0	0	0	0	27	27
White Fir	0	0	0	13	0	0	0	0	0	13
California Red Fir	0	0	0	0	13	0	0	0	0	13
Japanese Red Pine	0	0	0	0	0	0	13	0	0	13
Sitka Spruce	0	0	0	13	0	0	0	0	0	13
Southwestern White Pine	0	0	0	0	0	0	13	0	0	13
CEL Total	**201**	**227**	**441**	**669**	**565**	**455**	**268**	**120**	**241**	**3,157**

Tree Type	DBH (in.)									
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total
Northern White Cedar	120	722	348	27	54	0	80	13	13	1,378
Oriental Arborvitae	54	120	254	80	54	40	13	0	0	615
Austrian Pine	13	40	13	40	54	0	0	13	0	174
Incense Cedar	0	27	27	67	0	13	13	13	0	161
Black Spruce	0	0	0	27	13	0	0	0	0	40
CEM Other	0	0	27	0	0	0	0	0	0	27
Rocky Mountain Juniper	0	0	0	0	0	0	0	0	13	13
Jack Pine	0	0	0	0	13	0	0	0	0	13
CEM Total	**187**	**910**	**669**	**241**	**187**	**54**	**107**	**40**	**27**	**2,421**

Tree Type	DBH (in.)									
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total
CES Other	13	67	0	13	0	0	0	0	67	167
Lodgepole Pine	40	40	40	13	13	0	0	0	0	147
Pinyon	0	0	0	40	40	27	13	0	13	134
Western Juniper	27	0	13	13	0	13	13	0	0	80
Sawara False Cypress	0	27	0	27	0	0	0	13	0	67
Singleleaf Pinyon	27	0	0	0	13	0	0	0	13	54
Mountain Hemlock	0	0	0	13	0	0	0	0	0	13
CES Total	**107**	**134**	**54**	**120**	**67**	**40**	**27**	**13**	**94**	**655**

Tree Type	DBH (in.)									
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total
PEL Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Tree Type	DBH (in.)									
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total
PEM Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Tree Type	DBH (in.)									
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total
Mexican Fan Palm	0	13	13	0	0	0	0	0	0	27
PES Total	**0**	**13**	**13**	**0**	**0**	**0**	**0**	**0**	**0**	**27**

Tree Type	DBH (in.)									
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total
Total Population	*5,979*	*4,855*	*5,243*	*4,267*	*2,648*	*1,766*	*1,338*	*535*	*789*	*27,419*

Table A-2. *Replacement values for select street tree species by DBH class (dollars).*

	DBH Class (in.)									
Species	**0-3**	**3-6**	**6-12**	**12-18**	**18-24**	**24-30**	**30-36**	**36-42**	**>42**	**% of Total**
Japanese Maple	181,205	177,731	330,950	629,566	1,811,818	1,545,491	1,773,486	0	1,045,217	5.06
Japanese Fl. Cherry	104,595	212,510	428,423	1,423,685	1,029,876	1,571,698	1,255,462	583,048	0	4.46
Norway Maple	26,204	243,735	878,401	2,202,319	1,484,234	1,092,544	692,344	0	0	4.46
Nothern White Cedar	11,050	303,939	523,720	87,954	432,673	0	1,263,609	216,568	252,294	2.09
European White Birch	16,987	46,735	335,890	943,451	566,514	1,174,213	0	436,885	0	2.37
Red Maple	17,826	102,400	569,435	779,780	540,765	0	160,597	0	0	1.46
Pacific Dogwood	80,003	65,478	251,104	52,387	242,672	659,725	490,640	0	397,928	1.51
Douglas Fir	6,223	8,036	131,357	356,446	1,919,986	3,521,936	2,837,578	2,475,063	0	7.59
Flowering Pear	12,752	30,267	192,584	1,896,841	433,053	208,780	0	0	0	1.87
Maple	18,800	156,092	140,456	335,417	126,929	417,560	439,190	0	0	1.10
Oriental Arborvitae	7,295	67,595	397,482	402,737	432,673	757,885	266,023	0	0	1.57
Vine Maple	7,938	58,029	204,691	462,236	272,266	116,422	735,961	1,025,361	678,818	2.40
Black Cherry	0	34,111	134,477	311,239	952,931	164,931	0	0	0	1.08
Oregon Ash	2,153	48,890	251,930	116,294	108,863	460,693	0	0	0	0.67
Pacifc Rhododendron	4,470	14,701	49,232	0	806,374	356,154	2,067,854	740,129	862,017	3.31
Oregon White Oak	7,267	0	27,539	0	390,915	2,170,111	1,064,825	3,321,134	407,235	4.98
European Linden	37,762	15,158	130,388	0	0	0	901,106	0	541,118	1.10
Western Red Cedar	1,742	0	105,451	310,955	494,148	814,947	825,926	544,367	1,268,384	2.94
Blue Spruce	10,036	2,839	37,005	460,851	591,992	179,547	0	0	0	0.86
Pacific Bayberry	44,962	0	0	0	0	0	0	0	0	0.03
Common Chokecherry	3,736	6,665	210,641	261,933	201,240	0	0	0	0	0.46
Silver Maple	4,470	5,189	147,696	0	507,717	417,560	750,283	433,869	0	1.53
Red Alder	11,175	51,454	0	0	52,265	147,374	0	0	0	0.18
Deodar Cedar	0	0	29,001	236,087	477,743	430,954	376,866	0	1,225,427	1.87
Incense Cedar	0	13,708	49,472	324,042	0	252,628	376,866	525,951	0	1.04
Sweetgum	0	0	96,125	255,149	297,663	202,933	0	0	0	0.57
Bigleaf Maple	0	3,121	0	119,286	231,486	315,383	470,142	0	541,118	1.13
Giant Sequoia	0	0	0	0	0	0	0	0	5,836,600	3.94
Tulip Tree	1,824	0	0	134,246	153,238	609,280	376,866	525,951	0	1.21
Camperdown Elm	13,230	6,665	42,842	0	0	0	0	0	0	0.04
Fremont Cottonwood	0	0	0	0	0	223,396	333,017	0	1,145,897	1.15
Ponderosa Pine	0	3,365	0	81,327	0	0	0	0	0	0.06
Coast Redwood	0	0	0	0	0	0	0	0	592,103	0.40
Citywide Total	**942,575**	**2,328,613**	**8,127,469**	**18,363,630**	**21,405,042**	**25,275,057**	**27,154,233**	**16,729,692**	**27,946,700**	100